



US009354477B2

(12) **United States Patent**
Yang et al.

(10) **Patent No.:** **US 9,354,477 B2**
(45) **Date of Patent:** **May 31, 2016**

(54) **LIQUID CRYSTAL DISPLAY AND METHOD OF MANUFACTURING THE SAME**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Samsung Display Co., Ltd.**, Yongin, Gyeonggi-Do (KR)
(72) Inventors: **Ji Seong Yang**, Seoul (KR); **Dae Ho Lee**, Seoul (KR); **Yong Seok Kim**, Seoul (KR); **Han Joon Yoo**, Seoul (KR); **Seon Uk Lee**, Seongnam-si (KR)

5,122,225	A	6/1992	Douglas
7,838,351	B2	11/2010	Toyota et al.
2012/0062448	A1	3/2012	Kim et al.
2013/0087801	A1	4/2013	Kurita
2013/0093985	A1	4/2013	Kang et al.
2013/0112979	A1	5/2013	Nam et al.
2013/0250220	A1*	9/2013	Kim G02F 1/1341
			349/123
2014/0347611	A1*	11/2014	Kim et al. 349/106

(73) Assignee: **Samsung Display Co., Ltd.** (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 54 days.

FOREIGN PATENT DOCUMENTS

JP	2001-183680	A	7/2001
JP	2008-033117	A	2/2008
JP	2008-242031	A	10/2008
JP	2009-103769	A	5/2009

(Continued)

(21) Appl. No.: **14/251,319**

(22) Filed: **Apr. 11, 2014**

(65) **Prior Publication Data**

US 2015/0138478 A1 May 21, 2015

Primary Examiner — Nathanael R Briggs

Assistant Examiner — William Peterson

(74) *Attorney, Agent, or Firm* — Innovation Counsel LLP

(30) **Foreign Application Priority Data**

Nov. 19, 2013 (KR) 10-2013-0140768

(51) **Int. Cl.**

G02F 1/136 (2006.01)

G02F 1/1362 (2006.01)

G02F 1/1341 (2006.01)

G02F 1/1333 (2006.01)

(52) **U.S. Cl.**

CPC **G02F 1/136209** (2013.01); **G02F 1/133377** (2013.01); **G02F 1/1341** (2013.01); **G02F 1/133345** (2013.01); **G02F 2001/136222** (2013.01)

(58) **Field of Classification Search**

CPC **G02F 1/136209**; **G02F 1/133512**

USPC 349/44

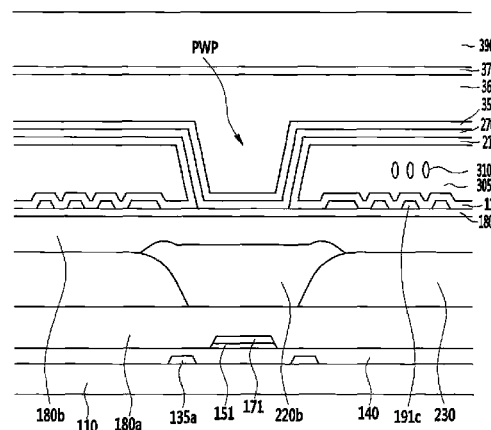
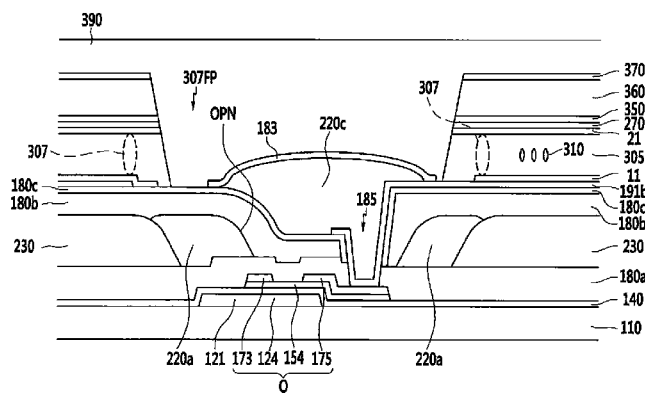
See application file for complete search history.

(57)

ABSTRACT

A liquid crystal display includes a substrate, a thin film transistor, a first protection layer, a pixel electrode, a light blocking layer, a second protection layer, and a roof layer. The thin film transistor is disposed on the substrate. The first protection layer is disposed on the thin film transistor. The pixel electrode is disposed on the first protection layer. The light blocking layer is disposed on the pixel electrode to cover the thin film transistor. The second protection layer is disposed on the light blocking layer. The roof layer is disposed to face the pixel electrode, wherein a plurality of microcavities having injection holes are formed between the pixel electrode and the roof layer. The microcavities comprise liquid crystal molecules, and the first protection layer and the second protection layer have different etch rates.

20 Claims, 21 Drawing Sheets



(56)

References Cited

JP

FOREIGN PATENT DOCUMENTS
2009-122601 A 6/2009

KR 10-0688958 B1 2/2007
KR 10-2008-0049193 A 6/2008
KR 10-2012-0048434 A 5/2012

* cited by examiner

FIG. 2

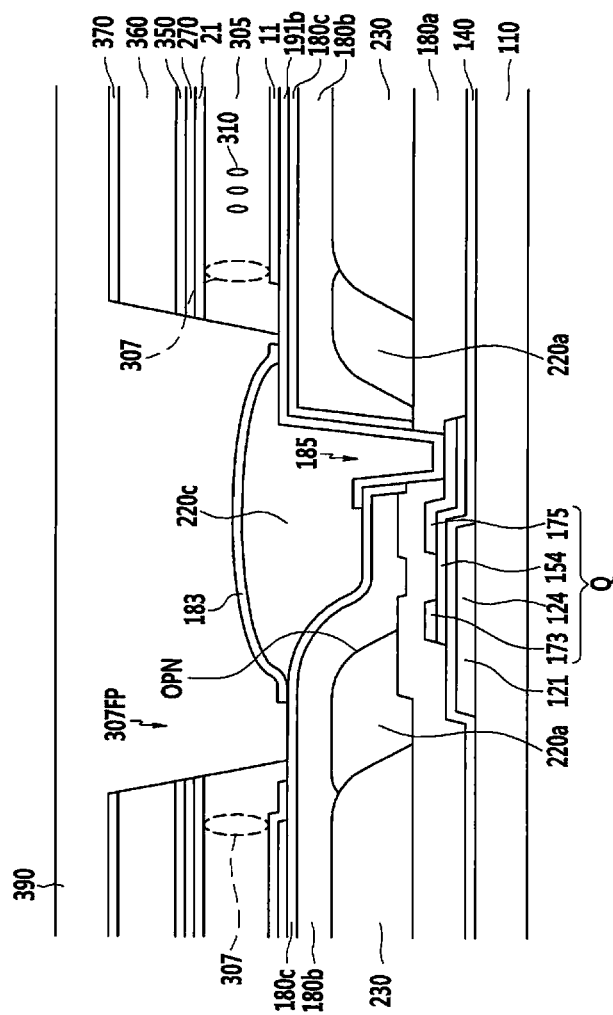


FIG. 3

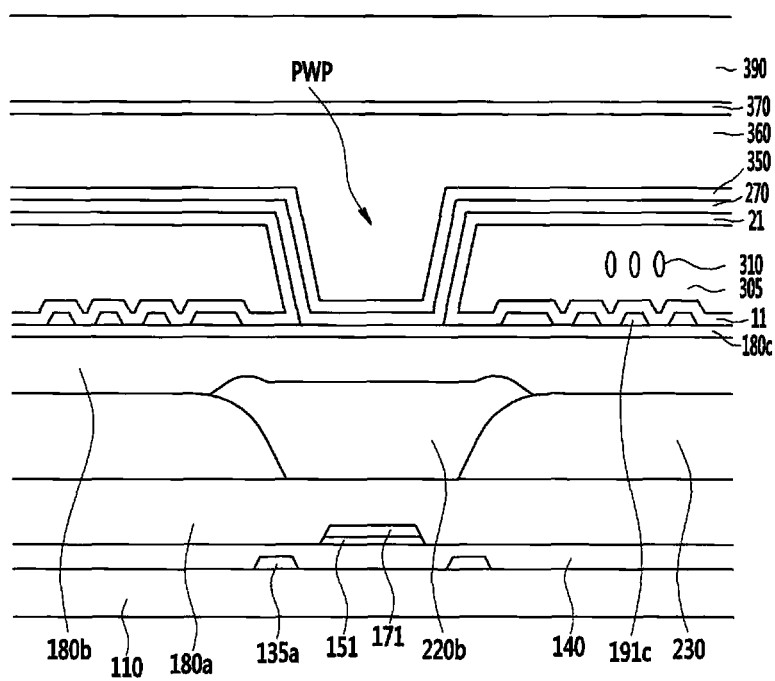


FIG. 4

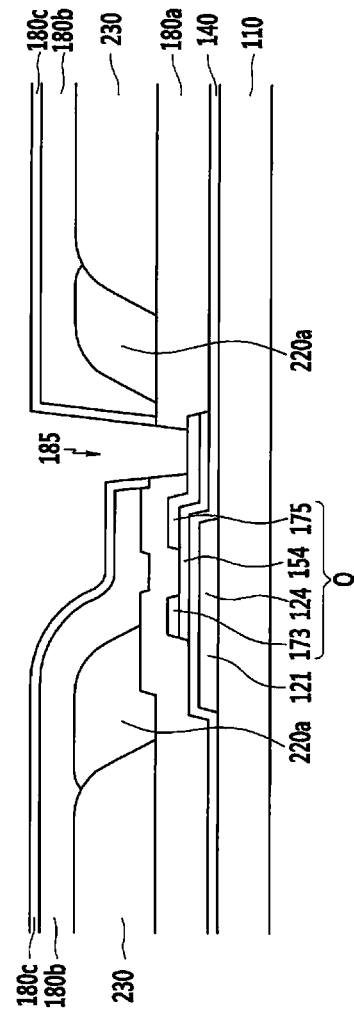


FIG. 5

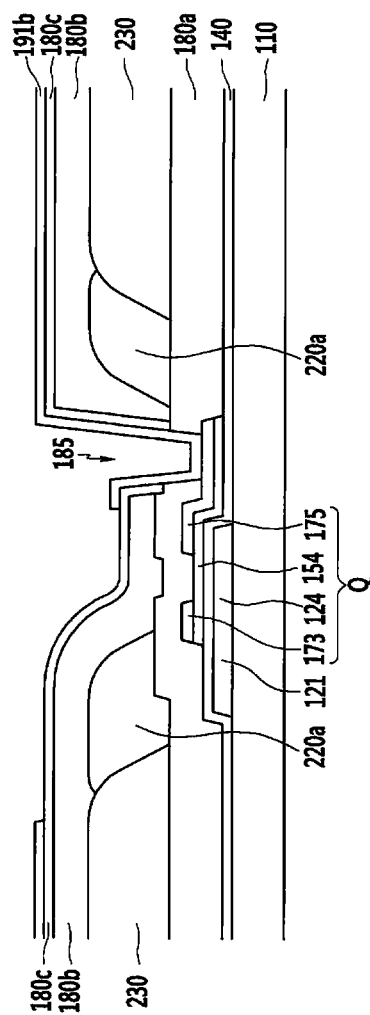


FIG. 6

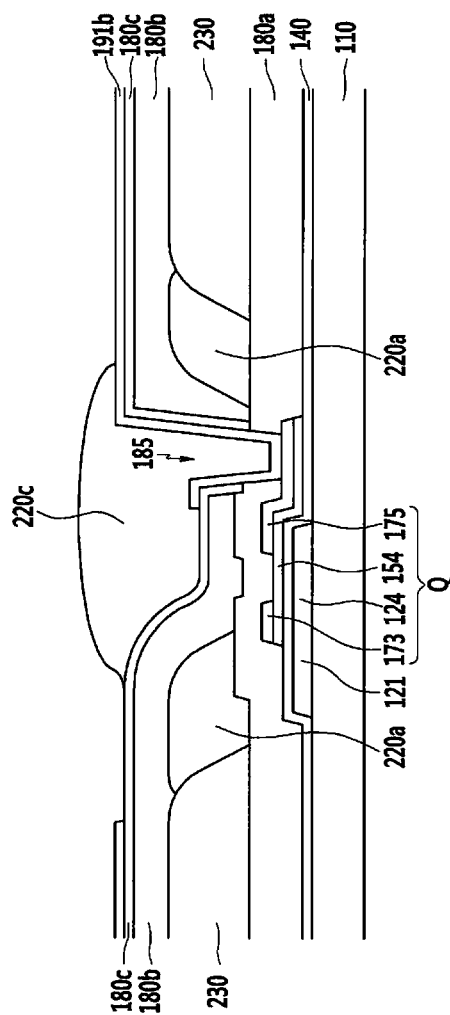


FIG. 7

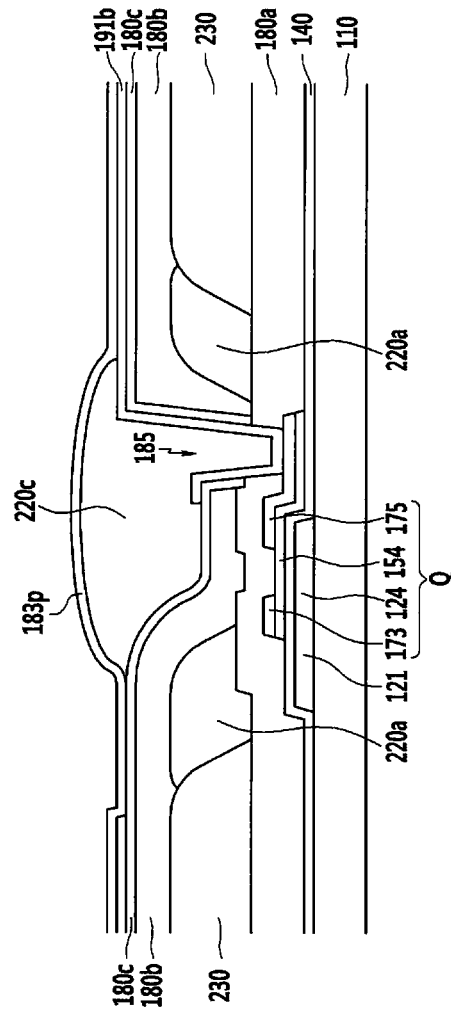


FIG. 8

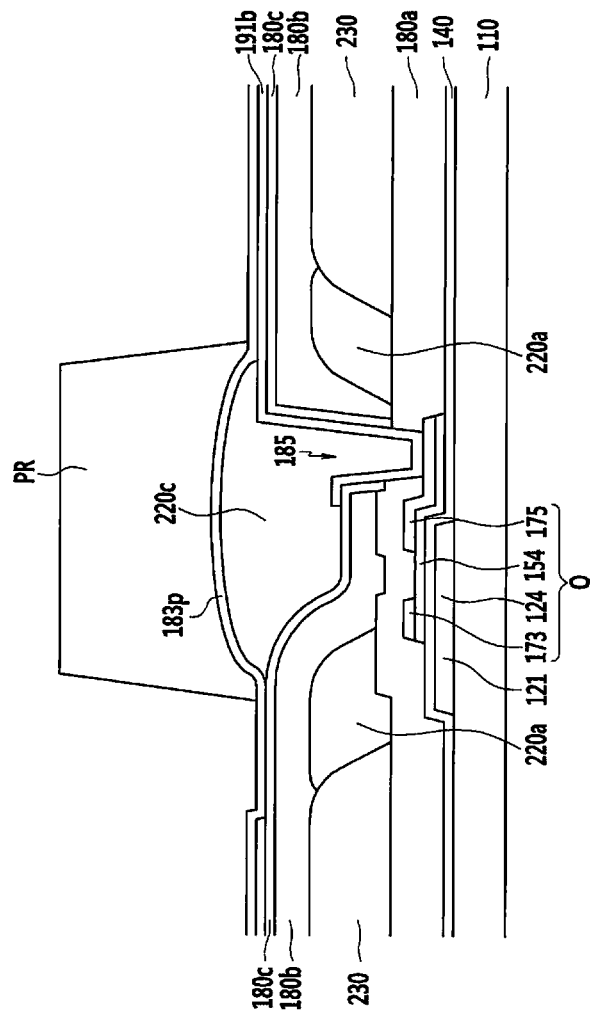


FIG. 9

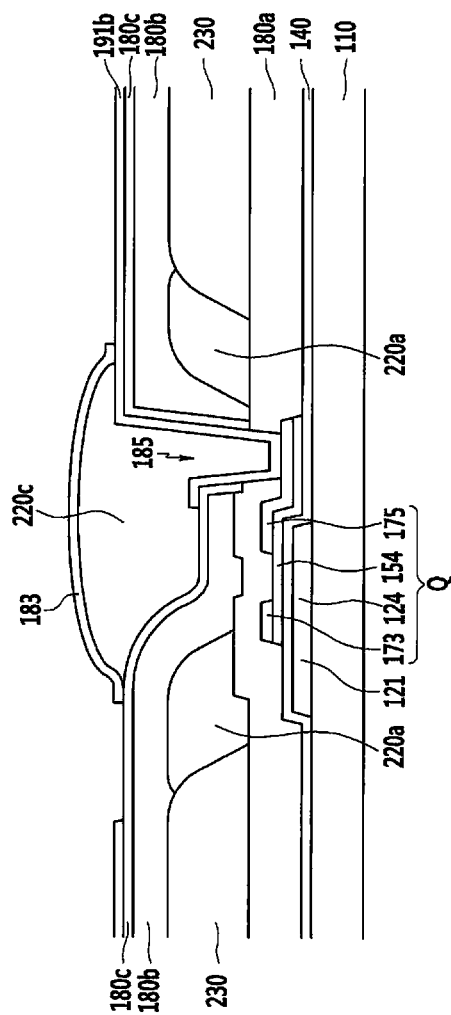


FIG. 11

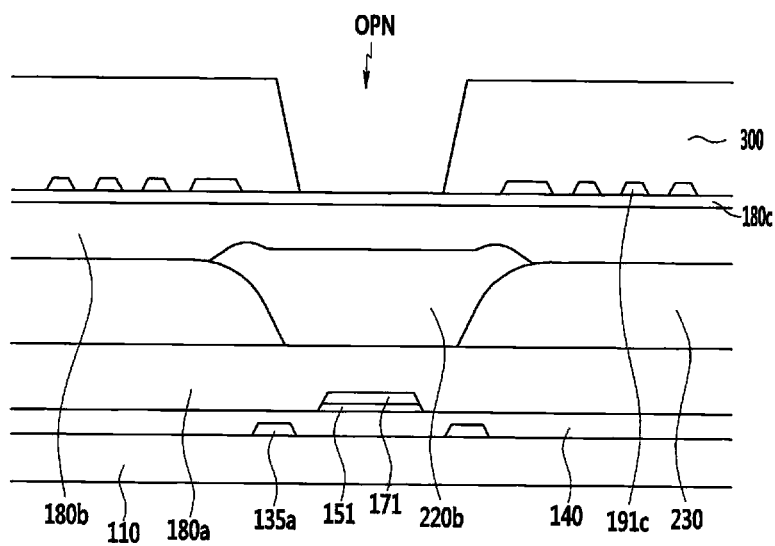


FIG. 12

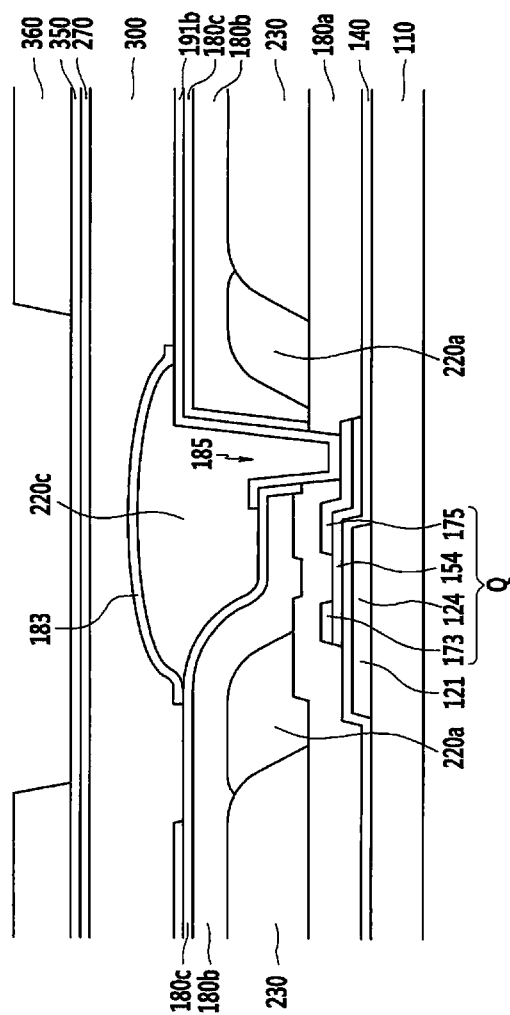


FIG. 13

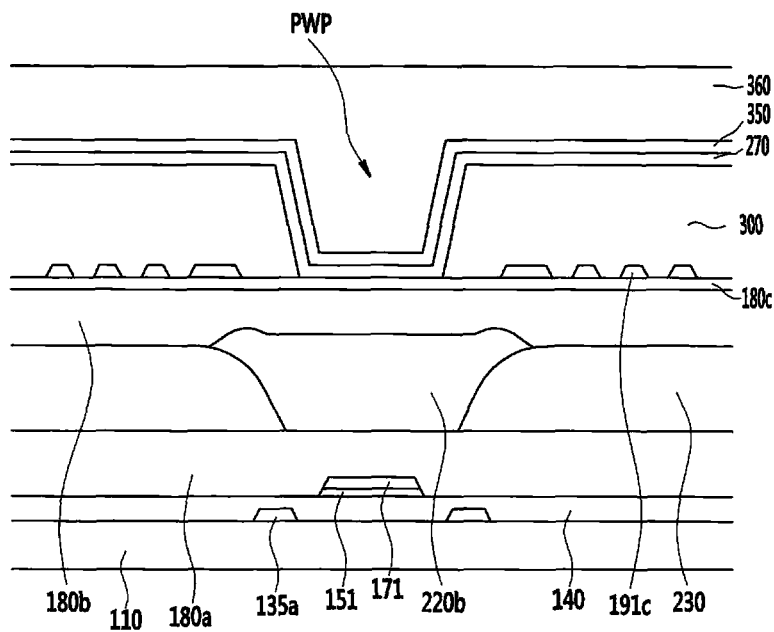


FIG. 14

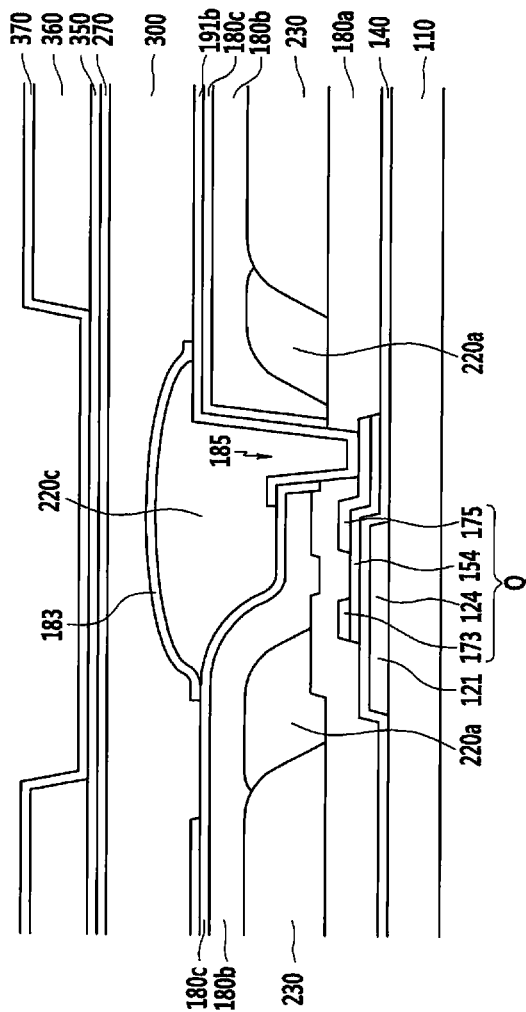


FIG. 15

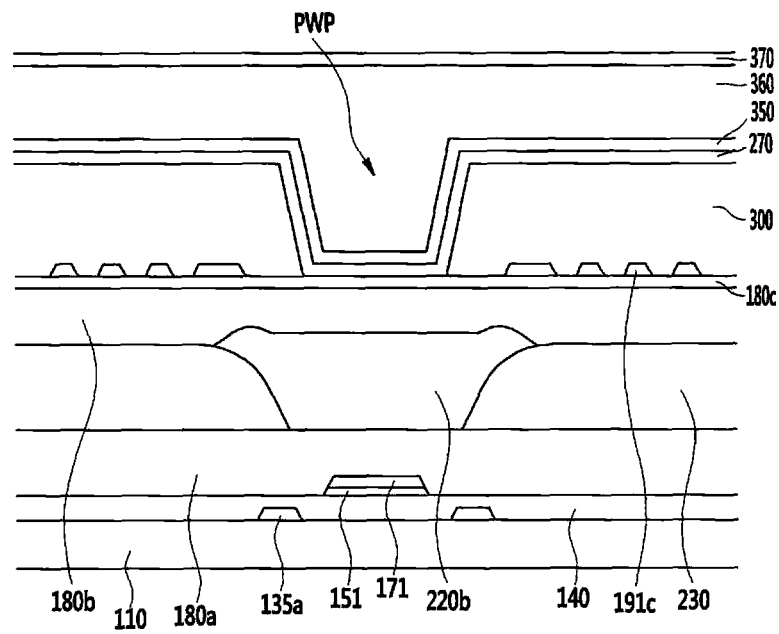


FIG. 16

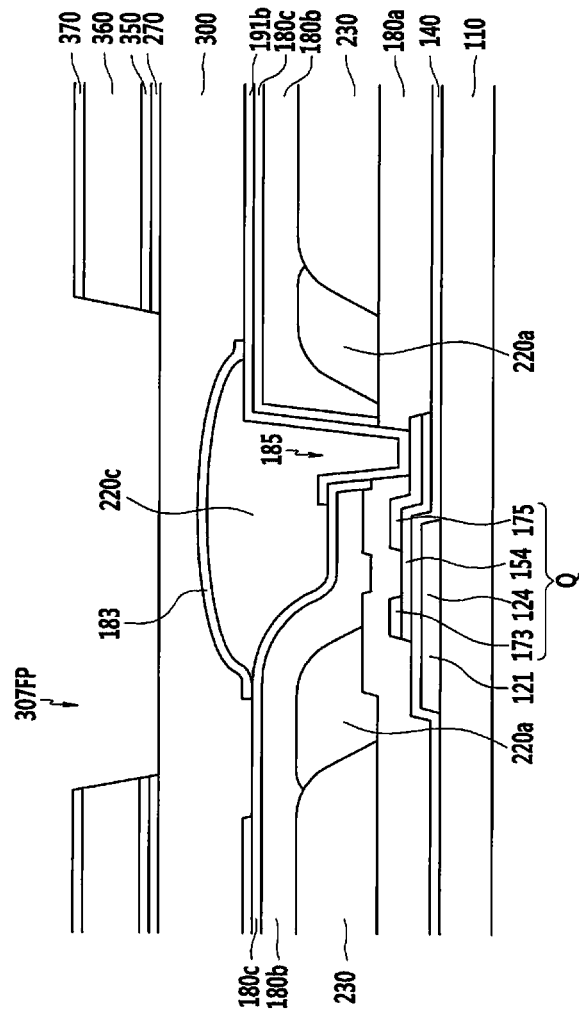


FIG. 17

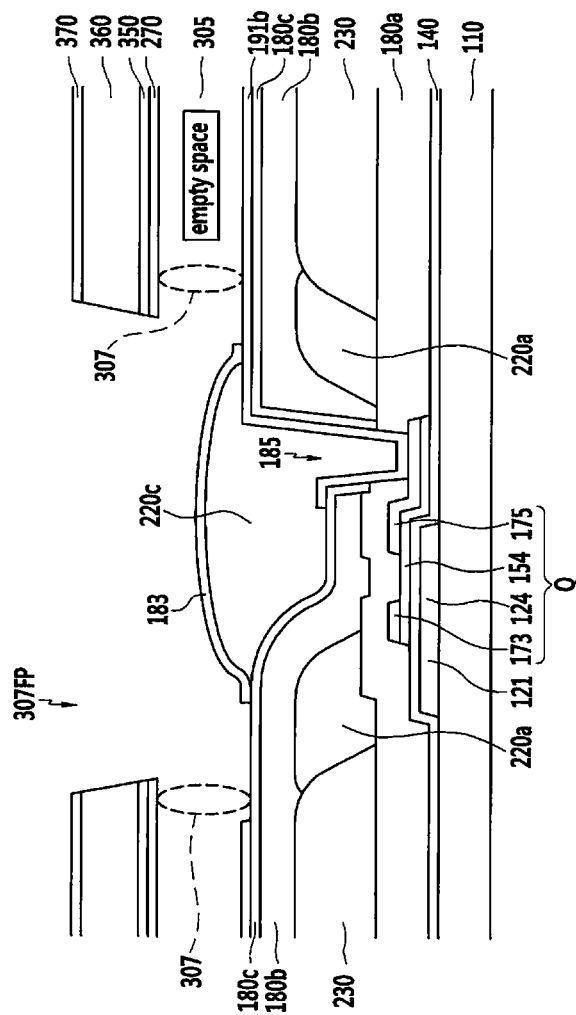


FIG. 18

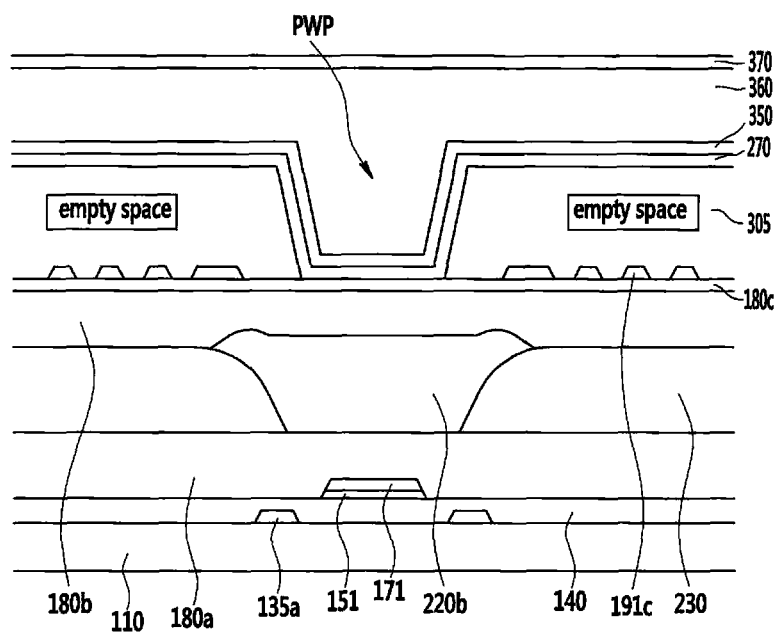


FIG. 19

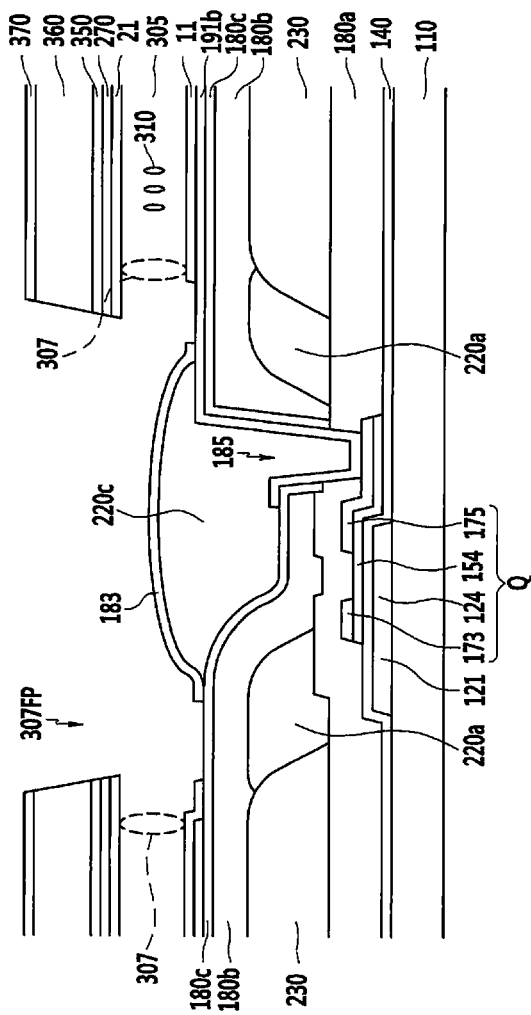


FIG. 20

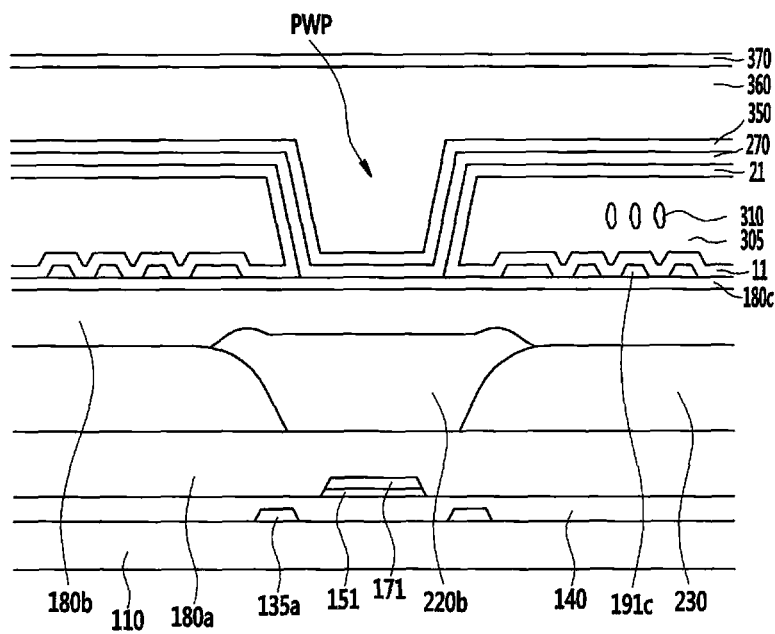
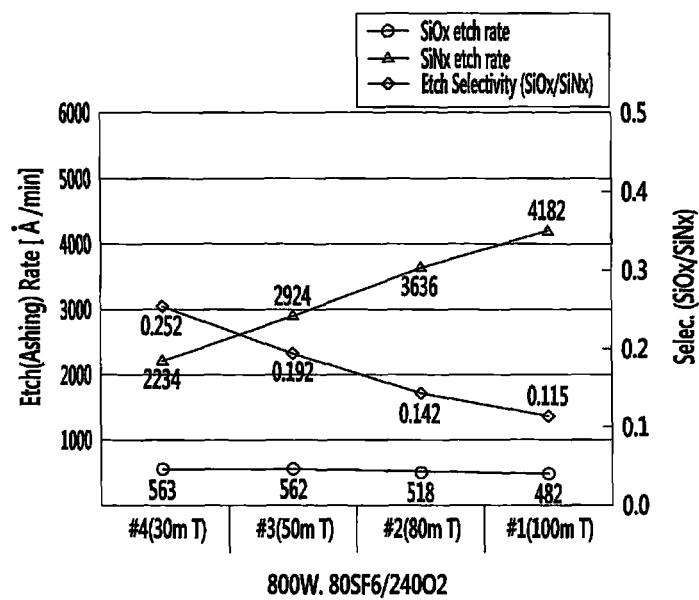


FIG. 21



LIQUID CRYSTAL DISPLAY AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2013-0140768 filed in the Korean Intellectual Property Office on Nov. 19, 2013, the entire contents of which are incorporated herein by reference.

BACKGROUND

(a) Field

The preset application relates to a liquid crystal display and a manufacturing method thereof.

(b) Description of the Related Art

A liquid crystal display as one of flat panel display devices that are being widely used includes two display panels, wherein field generating electrodes such as a pixel electrode and a common electrode are formed with a liquid crystal layer interposed therebetween.

The liquid crystal display generates an electric field in a liquid crystal layer by applying a voltage to the field generating electrodes to determine orientations of liquid crystal molecules of the liquid crystal layer and control polarization of incident light, thereby displaying an image.

A technique of forming a cavity in a pixel and filling the cavity with liquid crystals to implement a display has been developed for one of the liquid crystal displays. Although two sheets of substrates are used in a conventional liquid crystal display, this technique forms constituent elements on one substrate, thereby reducing weight, thickness, and the like of the device.

In the manufacturing process of a display which forms a plurality of microcavities, for repair of the thin film transistor, a light blocking member may be opened in a thin film transistor formation region. To prevent light leakage that may be generated in the thin film transistor formation region where the light blocking member is opened, an additional light blocking layer may be formed after forming the pixel electrode.

However, in a following process such as an ashing process to form the microcavities, the described light blocking layer may be damaged.

The above information disclosed in this Background section is only for enhancement of understanding of the background and therefore it may comprise information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

Embodiments have been made in an effort to provide a liquid crystal display and a manufacturing method thereof, having features of including a light blocking layer which is not damaged by a following process.

Further, embodiments have been made in an effort to provide a liquid crystal display and a manufacturing method thereof, having features of preventing undercutting from being generated when a protection layer for capping a light blocking layer is etched in the liquid crystal display which forms a plurality of microcavities.

An exemplary embodiment provides a liquid crystal display including a substrate, a thin film transistor, a first protection layer, a pixel electrode, a light blocking layer, a second protection layer, and a roof layer. The thin film transistor is

disposed on the substrate. The first protection layer is disposed on the thin film transistor. The pixel electrode is disposed on the first protection layer. The light blocking layer is disposed on the pixel electrode to cover the thin film transistor. The second protection layer is disposed on the light blocking layer. The roof layer is disposed to face the pixel electrode, wherein a plurality of microcavities having injection holes are formed between the pixel electrode and the roof layer. The microcavities comprise liquid crystal molecules, and the first protection layer and the second protection layer have different etch rates.

The first protection layer and the second protection layer may comprise different materials.

The second protection layer may have high etch selectivity as compared with the first protection layer.

The first protection layer may include a silicon oxide (SiO_x) and the second protection layer may include a silicon nitride (SiN_x).

The liquid crystal display may further include an interlayer insulating layer disposed between the thin film transistor and the pixel electrode. The pixel electrode and the thin film transistor may be connected to each other through a contact hole formed penetrating through the interlayer insulating layer and the first protection layer.

The second protection layer may have a wider width than that of the light blocking layer to cover the light blocking layer.

The liquid crystal display may further include a light blocking member disposed between the thin film transistor and the interlayer insulating layer, and the light blocking member may have an open portion corresponding to the thin film transistor.

The liquid crystal display may further include a color filter disposed between the thin film transistor and the interlayer insulating layer.

The liquid crystal display may further include a capping layer disposed on the roof layer to cover the injection hole.

The liquid crystal display may further include a common electrode disposed between the microcavities and the roof layer.

Another embodiment provides a manufacturing method of a liquid crystal display as follows. A thin film transistor is formed on a substrate. A first protection layer is formed on the thin film transistor. A pixel electrode is formed on the first protection layer. A light blocking layer is formed on the pixel electrode to cover the thin film transistor. A second protection layer is formed on the light blocking layer. A sacrificial layer is formed on the pixel electrode. A roof layer is formed on the sacrificial layer. A plurality of microcavities having injection holes are formed by removing the sacrificial layer. A liquid crystal material is injected into the microcavities, wherein the first protection layer and the second protection layer have different etch rates.

The forming of the second protection layer may include: forming a protection material layer on the pixel electrode to cover the light blocking layer; and patterning the protection material layer to form the second protection layer.

The second protection layer may have high etch selectivity as compared with the first protection layer.

The first protection layer may include a silicon oxide (SiO_x) and the second protection layer may include a silicon nitride (SiN_x).

The manufacturing method may further include forming an interlayer insulating layer between the thin film transistor and the pixel electrode. The pixel electrode and the thin film transistor may be connected to each other through a contact

hole formed penetrating through the interlayer insulating layer and the first protection layer.

The second protection layer may be formed to have a wider width than that of the light blocking layer to cover the light blocking layer.

The manufacturing method may further include forming a light blocking member between the thin film transistor and the interlayer insulating layer. The light blocking member may be formed to have an open portion corresponding to the thin film transistor.

The manufacturing method may further include forming a color filter between the thin film transistor and the interlayer insulating layer.

The manufacturing method may further include forming a capping layer on the roof layer to cover the injection holes.

The manufacturing method may further include forming a common electrode between the microcavities and the roof layer.

In accordance with the exemplary embodiments, the light blocking layer formed after the pixel electrode is covered with the protection layer, and thus the light blocking layer is not damaged in a strip process for forming the microcavities.

Further, in accordance with the exemplary embodiments, it is possible to prevent undercutting from being generated when the protection layer is etched for the light blocking layer by using the etch selectivity of the protection layer for capping the organic layers disposed with the pixel electrode therebetween and the protection layer for capping the light blocking layer in the liquid crystal display which forms the microcavities.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view showing a liquid crystal display in accordance with an exemplary embodiment.

FIG. 2 is a cross-sectional view taken along a line II-II of FIG. 1.

FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 1.

FIGS. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 are stepwise cross-sectional views showing a manufacturing method of a liquid crystal display in accordance with another exemplary embodiment.

FIG. 21 is a graph showing an etch rate and etch selectivity of a silicon oxide and a silicon nitride.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Hereinafter, exemplary embodiments will be described in detail with reference to the accompanying drawings. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the inventive concept. On the contrary, exemplary embodiments introduced herein are disposed to make disclosed contents thorough and complete, and sufficiently transfer the spirit of the inventive concept to those skilled in the art.

In the drawings, the thickness of layers, films, panels, regions, etc., are exaggerated for clarity. It will be understood that when a layer is referred to as being "on" another layer or substrate, it can be directly on the other layer or substrate, or intervening elements may also be present. Like reference numerals designate like elements throughout the specification.

FIG. 1 is a top plan view showing a liquid crystal display in accordance with an exemplary embodiment. FIG. 2 is a cross-

sectional view taken along a line II-II of FIG. 1. FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 1.

Referring to FIGS. 1 to 3, a gate line **121** and a storage electrode line **131** are formed on an insulating substrate **110** formed of transparent glass or plastic. The gate line **121** includes a gate electrode **124**. The storage electrode line **131** is mainly extended in a horizontal direction, and transfers a predetermined voltage such as a common voltage V_{com} . The storage electrode line **131** includes a pair of vertical storage electrode portions **135a** substantially extended to be perpendicular to the gate line **121**, and a horizontal storage electrode portion **135b** connecting ends of the pair of vertical storage electrode portions **135a** to each other. The storage electrode portions **135a** and **135b** have a structure surrounding a pixel electrode **191**.

A gate insulating layer **140** is formed on the gate line **121** and the storage electrode line **131**. A semiconductor layer **151** positioned at a lower portion of a data line **171**, and a semiconductor layer **154** positioned at a lower portion of a source/drain electrode and at a channel portion of a thin film transistor Q, are formed on the gate insulating layer **140**.

A plurality of ohmic contact layers may be formed on each of the semiconductor layers **151** and **154**, and between the data line **171** and the source/drain electrode, but this is omitted in the drawings.

Data conductors **171**, **173**, and **175** including a source electrode **173**, the data line **171** connected with the source electrode **173**, and a drain electrode **175** are formed on each of the semiconductor layers **151** and **154** and the gate insulating layer **140**.

The gate electrode **124**, the source electrode **173**, and the drain electrode **175** form the thin film transistor Q together with the semiconductor layer **154**, and a channel of the thin film transistor Q is formed on the portion of the semiconductor layer **154** between the source electrode **173** and the drain electrode **175**.

A first interlayer insulating layer **180a** is formed on the data conductors **171**, **173**, and **175**, and an exposed portion of the semiconductor layer **154**. The first interlayer insulating layer **180a** may include an inorganic insulating material, such as a silicon nitride (SiNx) and a silicon oxide (SiOx), or an organic insulating material.

A color filter **230** and light blocking members **220a** and **220b** are formed on the first interlayer insulating layer **180a**.

Each of the light blocking members **220a** and **220b** has a lattice structure having an opening corresponding to a region displaying an image, and is formed of a material preventing light from being transmitted therethrough. The color filter **230** is formed at openings of the light blocking members **220a** and **220b**.

The light blocking members **220a** and **220b** include a horizontal light blocking member **220a** formed in a direction parallel to the gate line **121**, and a vertical light blocking member **220b** formed in a direction parallel to the data line **171**. In the present exemplary embodiment, the horizontal light blocking member **220a** has an open portion OPN corresponding to the thin film transistor Q to repair the thin film transistor Q during the manufacturing process. In other words, the open portion OPN of the horizontal light blocking member **220a** may be formed with a portion corresponding to a region at which the thin film transistor Q is formed.

The color filter **230** may display one of primary colors, such as three primary colors including red, green, and blue. However, the colors are not limited to the three primary colors including red, green, and blue, and the color filter **230** may also display one among a cyan-based color, a magenta-based color, a yellow-based color, and a white-based color. The

5

color biter **230** may be formed of materials displaying different colors for each adjacent pixel.

A second interlayer insulating layer **180b** covering the color filter **230** and the light blocking members **220a** and **220b** is formed on the color filter **230** and the light blocking members **220a** and **220b**. The second interlayer insulating layer **180b** may include the inorganic insulating material, such as a silicon nitride (SiNx) and a silicon oxide (SiOx), or the organic insulating material. Unlike the cross-sectional view of FIG. 2, in a case where a step is generated due to a difference in a thickness between the color filter **230** and the light blocking members **220a** and **220b**, the second interlayer insulating layer **180b** includes an organic insulating material, so that it is possible to decrease or remove the step.

A first protection layer **180c** is formed on the second interlayer insulating layer **180b**. The first protection layer **180c** may be made of an inorganic material for protecting the second interlayer insulating layer **180b**. For example, the first protection layer **180c** may be made of a silicon oxide (SiOx).

The interlayer insulating layers **180a** and **180b** and the first protection layer **180c** have a contact holes **185** extending to and exposing the drain electrode **175**.

The pixel electrode **191** is disposed on the first protection layer **180c**. The pixel electrode **191** may be formed of a transparent conductive material such as ITO or IZO.

An overall shape of the pixel electrode **191** is a quadrangle, and the pixel electrode **191** includes cross stems configured by a horizontal stem **191a** and a vertical stem **191b** crossing the horizontal stem **191a**. Further, the pixel electrode **191** is divided into four sub-regions by the horizontal stem **191a** and the vertical stem **191b**, and each subregion includes a plurality of minute branches **191c**. In the present exemplary embodiment, the pixel electrode **191** may further include an outer stem surrounding an outer circumference of the pixel electrode **191**.

The minute branches **191c** of the pixel electrode **191** form an angle of approximately 40° to 45° with the gate line **121** or the horizontal stem **191a**. Further, the minute branches **191c** of two adjacent sub-regions may be perpendicular to each other. Furthermore, a width of each minute branch **191c** may be gradually increased, or a distance between the minute branches **191c** may be varied.

The pixel electrode **191** is physically and electrically connected to the drain electrode **175** through the contact hole **185**, and receives a data voltage from the drain electrode **175**.

The thin film transistor Q and the pixel electrode **191** described above are merely exemplary, and a structure of the thin film transistor and a design of the pixel electrode may be modified in order to improve side visibility.

In the present exemplary embodiment as illustrated in FIG. 2, an injection hole forming region **307FP** is formed between microcavities **305** adjacent in the vertical direction. A light blocking layer **220c** covering the thin film transistor Q and the contact hole **185** is formed within the injection hole forming region **307FP**. The light blocking layer **220c** is formed of a material capable of blocking light in order to decrease a leakage current of the thin film transistor Q by external light and prevent a decrease in a contrast ratio due to reflective light. The light blocking layer **220c** may be made of an organic material. The light blocking layer **220c** may be made of the same material as that of the light blocking members **220a** and **220b**.

A second protection layer **183** is disposed on the light blocking layer **220c**. The second protection layer **183** includes a material having an etch rate that is different from that of the first protection layer **180c**. The second protection layer **183** includes a silicon nitride (SiNx).

6

In the present exemplary embodiment, the second protection layer **183** has etch selectivity that is greater than that of the first protection layer **180c**. Specifically, in the case of an etchant used in a patterning process for forming the second protection layer **183** shown in FIG. 2 in the present exemplary embodiment, the second protection layer **183** has etch selectivity that is very high compared with the first protection layer **180c**. Accordingly, it is possible to selectively etch the second protection layer **183** while minimizing etching of the first protection layer **180c**. Therefore, it is possible to prevent generation of undercutting caused by the etching of the first protection layer **180c** below the pixel electrode **191** in the process for forming the second protection layer **183**.

Hereinafter, etch selectivities of the first protection layer **180c** and the second protection layer **183** will be described with reference to FIG. 21.

FIG. 21 is a graph showing an etch rate and etch selectivity of silicon oxide and silicon nitride.

Referring to FIG. 21, the etch rate of silicon nitride is higher than that of the silicon oxide, and the etch selectivity of the silicon oxide is equal to or smaller than 0.25 as compared with the silicon nitride. In the graph of FIG. 21, the horizontal axis indicates a process pressure (unit: mTorr), and SF₆/O₂ is employed as the etching gas. As such, since the difference between the etch rates of the silicon oxide and silicon nitride is large, a target material can be selectively etched. The silicon oxide and the silicon nitride are examples of the materials of the first protection layer **180c** and the second protection layer **183**, and may be replaced by a combination of materials having different etch rates.

Referring to FIG. 2 again, it is preferable that the second protection layer **183** has a wider width than that of the light blocking layer **220c** to completely cover the light blocking layer **220c**. The second protection layer **183** can serve to prevent the light blocking layer **220c** from being damaged in the manufacturing process of the liquid crystal display in accordance with the present exemplary embodiment.

A lower alignment layer **11** is formed on the pixel electrode **191**, and may be a vertical alignment layer. The lower alignment layer **11**, as a liquid crystal alignment layer made of a material such as polyamic acid, polysiloxane, polyimide, or the like, may include at least one of generally used materials.

An upper alignment layer **21** is positioned at a portion facing the lower alignment layer **11**, and the microcavity **305** is formed between the lower alignment layer **11** and the upper alignment layer **21**. A liquid crystal material including liquid crystal molecules **310** is injected into the microcavity **305** through an injection hole **307**. The microcavity **305** may be formed in a column direction, that is, a vertical direction, of the pixel electrode **191**. In the present exemplary embodiment, the alignment material forming the alignment layers **11** and **21** and the liquid crystal material including the liquid crystal molecules **310** may be injected into the microcavity **305** by using capillary force.

The microcavity **305** is divided in a vertical direction by a plurality of injection hole forming regions **307FP** positioned at a portion overlapping the gate line **121**, and a plurality of microcavities **305** may be formed along the direction in which the gate line **121** is extended. Each of the plurality of formed microcavities **305** may correspond to a pixel area, and the pixel areas may correspond to a region displaying an image.

In the present exemplary embodiment, since the liquid crystal material is injected through the injection hole **307** of the microcavity **305**, it is possible to form the liquid crystal display without forming a separate upper substrate.

A common electrode **270** and a lower insulating layer **350** are positioned on the upper alignment **21**. The common elec-

trode **270** receives the common voltage, and generates an electric field together with the pixel electrode **191** to which the data voltage is applied to determine a direction in which the liquid crystal molecules **310** positioned at the microcavity **305** between the two electrodes are inclined. The common electrode **270** forms a capacitor with the pixel electrode **191** to maintain the received voltage even after the thin film transistor is turned off. The lower insulating layer **350** may be formed of a silicon nitride (SiNx) or a silicon oxide (SiOx).

In the present exemplary embodiment, it is described that the common electrode **270** is formed on the microcavity **305**, but in another exemplary embodiment, the common electrode **270** is formed under the microcavity **305**, so that liquid crystal driving according to a coplanar electrode (CE) models possible.

A roof layer **360** is positioned on the lower insulating layer **350**. The roof layer **360** serves as a support so that the microcavity **305**, which is a space between the pixel electrode **191** and the common electrode **270**, is formed. The roof layer **360** may include silicon oxycarbide (SiOC), a photoresist, or other organic materials. In the case where the roof layer **360** includes the silicon oxycarbide (SiOC), the roof layer **360** may be formed by a chemical vapor deposition method, and in the case where the roof layer **360** includes the photoresist, the roof layer **360** may be formed by a coating method. The silicon oxycarbide (SiOC) has high transmittance among films formable by the chemical vapor deposition method, and has low film stress, thereby achieving a feature that the roof layer **360** is not deformed. Accordingly, in the present exemplary embodiment, when the roof layer **360** is formed of silicon oxycarbide (SiOC), a stable film through which light is transmitted well may be formed.

An upper insulating layer **370** is disposed on the roof layer **360**. The upper insulating layer **370** may be brought into contact with an upper surface of the roof layer **360**. The upper insulating layer **370** may be formed of a silicon nitride (SiNx) or a silicon oxide (SiOx). A capping layer **390** is disposed on the upper insulating layer **370**. The capping layer **390** is in contact with an upper surface and a side surface of the upper insulating layer **370**, and the capping layer **390** covers the injection hole **307** of the microcavity **305** exposed by the injection hole forming region **307FP**. The capping layer **390** may be formed of a thermosetting resin, silicon oxycarbide (SiOC), or graphene.

In the case where the capping layer **390** is formed of graphene, because the graphene has a characteristic of high impermeability for gas including helium, it may serve as a capping layer blocking the injection hole **307**, and because the graphene is a material formed by a carbon bond, the liquid crystal material is not contaminated even though graphene is brought into contact with the liquid crystal material. In addition, graphene may serve to protect the liquid crystal material from external oxygen and moisture.

An overcoat layer (not illustrated) formed of an inorganic layer or an organic layer may be positioned on the capping layer **390**. The overcoat layer serves to protect the liquid crystal molecules **310** injected to the microcavity **305** from an external impact, and planarize the layer.

The capping layer **390** may cover the light blocking layer **183** as well as the injection hole **307** and may be filled in the injection hole forming region **307FP** between the microcavities **303** and the light blocking layer **183**.

In the present exemplary embodiment as shown in FIG. 3, a partition wall formation portion PWP is positioned between the microcavities **305** adjacent to each other in a horizontal direction. The partition wall formation portion PWP may be formed in an extending direction of the data line **171**, and may

be covered by the roof layer **360**. The lower insulating layer **350**, the common electrode **270**, the upper insulating layer **370**, and the roof layer **360** are filled in the partition wall formation portion PWP, and the structure forms the partition wall to partition or define the microcavity **305**. In the present exemplary embodiment, since a partition wall structure such as the partition wall formation portion PWP exists between the microcavities **305**, even if the insulation substrate **110** is bent, generated stress is small, and a change degree of a cell gap may be considerably reduced.

A polarizer (not shown) is disposed below the substrate **110** and above the capping layer **390**. The polarizer may include a polarizing element generating polarized light and a tri-acetyl-cellulose (TAC) layer for securing durability, and depending on an exemplary embodiment directions of transmissive axes of an upper polarizer and a lower polarizer may be perpendicular or parallel to each other.

Hereinafter, a manufacturing method of the aforementioned liquid crystal display will be described with reference to FIG. 4 to FIG. 20 in accordance with another exemplary embodiment

The following exemplary embodiment may be modified into other methods as an exemplary embodiment of the manufacturing method.

FIG. 4 to FIG. 20 are stepwise cross-sectional views showing the manufacturing method of the liquid crystal display in accordance with the present exemplary embodiment. FIGS. 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 17, and 19 sequentially show the cross-sectional views taken along the line II-II of FIG. 1. FIGS. 11, 13, 15, 18, and 20 sequentially show the cross-sectional views taken along the line III-III of FIG. 1.

Referring to FIG. 4, in order to form a generally known switching element on a substrate **110**, the gate line **121** extended in the horizontal direction is formed, and the gate insulating layer **140** is formed on the gate line **121**, the semiconductor layers **151** and **154** are formed on the gate insulating layer **140**, and the source electrode **173** and the drain electrode **173** are formed. In this case, the data line **171** connected with the source electrode **173** may be formed in be extended in the vertical direction while crossing the gate line **121**.

The first interlayer insulating layer **180a** is formed on the data conductors **171**, **173**, and **175** including the source electrode **173**, the drain electrode **175**, and the data line **171**, and the exposed portion of the semiconductor layer **154**.

The color filter **230** is formed at a position corresponding to the pixel area on the first interlayer insulating layer **180a**, and the light blocking members **220a** and **220b** are formed between the color filters **230**. The light blocking members **220a** and **220b** include the horizontal light blocking member **220a** formed in a direction parallel to the gate line **121** and the vertical light blocking member **220b** formed in a direction parallel to the data line **171**.

In this case, the horizontal light blocking member **220a** is formed to open the thin film transistor Q to repair the thin film transistor Q in the manufacturing process.

The second interlayer insulating layer **180b** and the first protection layer **180c** are formed to cover the color filter **230** and the light blocking members **220a** and **220b**, and the second interlayer insulating layer **180b** and the first protection layer **180c** are formed to have the contact hole **185** electrically and physically connecting the pixel electrode **191** and the drain electrode **175**.

Referring to FIG. 5, the pixel electrode **191** is formed on the second interlayer insulating layer **180b**. At this time, as in the exemplary embodiment described with reference to FIG. 1 to FIG. 3, the pixel electrode **191** is formed to have the cross

stems **191a** and **191b** and the minute branches **191c** by using a photolithography process after being coated with a transparent conductive material such as ITO or IZO.

Referring to FIG. 6, the light blocking layer **220c** is formed on the pixel electrode **191** and the first protection layer **180c**. Further, the light blocking layer **220c** is formed in such a way so as to cover the thin film transistor Q and the contact hole **185**. When a fault is generated in the thin film transistor Q, a repair process of the thin film transistor Q may be performed before a forming process of the light blocking layer **220c**.

Referring to FIG. 7, a protection material layer **183p** is formed on the light blocking layer **220c**, the pixel electrode **191**, and the first protection layer **180c**. The protection material layer **183p** may be made of an inorganic material such as a silicon nitride.

Referring to FIG. 8, a photosensitive film pattern PR is formed on the protection material **183p**. The photosensitive film pattern PR may be formed on the substrate **110** to cover the thin film transistor Q and the contact hole **185**, and may be formed by using a positive photoresist.

Referring to FIG. 9, the protection material layer **183p** is patterned by using the photosensitive film pattern PR as a mask. In this case, the second protection layer **183** is formed to cover the thin film transistor Q and the contact hole **185**. In the present exemplary embodiment, the protection material layer **183p** and thus the second protection layer **183** has etch selectivity that is very high compared with the first protection layer **180c**. Accordingly, it is possible to selectively etch the protection material layer **183p** to form the second protection layer **183** while minimizing etching of the first protection layer **180c**. Therefore, it is possible to prevent generation of undercutting caused by the etching of the first protection layer **180c** below the pixel electrode **191** in the process for forming the second protection layer **183**.

Referring to FIG. 10 and FIG. 11, the remaining photosensitive film pattern PR is removed through a strip process, and a sacrificial layer **300** is formed on the pixel electrode **191** and the second protection layer **183**. The sacrificial layer **300** may be made of an organic material. As shown in FIG. 11, the open portion OPN is formed along a direction parallel with the data line **171** in the sacrificial layer **300**. In a subsequent process, the common electrode **270**, the lower insulating layer **350**, the roof layer **360**, and the upper insulating layer **370** are filled in the open portion OPN to form the partition wall formation portion PWP.

Referring to FIG. 12 and FIG. 13, the common electrode **270**, the lower insulating layer **350**, and the roof layer **360** are sequentially formed on the sacrificial layer **300**. The roof layer **360** may be removed at the region corresponding to the horizontal light blocking member **220a** positioned between the pixel areas adjacent in the vertical direction by an exposure and development process. The roof layer **360** exposes the lower insulating layer **350** in the region corresponding to the horizontal light blocking member **220a**. In this case, the common electrode **270**, the lower insulating layer **350**, and the roof layer **360** fill the open portion OPN formed above the vertical light blocking member **220b** thereby forming the partition forming portion PWP.

Referring to FIG. 14 and FIG. 15, the upper insulating layer **370** is formed in such a way so as to cover upper portions of the roof layer **360** and the exposed lower insulating layer **350**.

Referring to FIG. 16, the upper insulating layer **370**, the lower insulating layer **350**, and the common electrode **270** are dry-etched to partially remove the upper insulating layer **370**, the lower insulating layer **350**, and the common electrode

270, thereby forming the injection hole forming region **307FP**. To this case, the sacrificial layer **300** is exposed to the outside.

As shown in FIG. 16, the liquid crystal display is formed such that the upper insulating layer **370** which covers the side surface of the roof layer **360** is removed to expose a side surface of the roof layer **360** to the outside, but it is not limited thereto. Alternatively, the liquid crystal display may be formed such that the upper insulating layer **370** is formed to cover the side surface of the roof layer **360**.

Referring to FIG. 17 and FIG. 18, the sacrificial layer **300** is removed by an oxygen (O₂) ashing process or a wet-etching method through the injection hole forming region **307FP**. In this case, the microcavities **305** having the injection holes **307** are formed.

The microcavities **305** are in a state of an empty space according to the removal of the sacrificial layer **300**. The injection holes **307** may be formed along a direction in which the gate line **121** is extended. In the case that the sacrificial layer **300** is made of a material that is similar or identical to that of the light blocking layer **220c**, the light blocking layer **220c** may be damaged in the removing process of the sacrificial layer **300**. As a result, the light blocking layer **220c** cannot cover the thin film transistor Q and the contact hole **1851** thereby deteriorating reliability of the liquid crystal display. However, in the present exemplary embodiment, the light blocking layer **220c** is surrounded by the second protection layer **183**, and thus it is possible to prevent damage to the light blocking layer **220c** in the removing process of the sacrificial layer **300**.

Referring to FIG. 19 and FIG. 20, the alignment layers **11** and **21** are formed on the pixel electrode **191** and the common electrode **270** by performing a baking process after injecting an aligning material including a solid content and a solvent through the injection holes **307**.

Next, the liquid crystal material including the liquid crystal molecules **310** is injected into the microcavities **305** through the injection holes **307** by using an inkjet method and the like.

Thereafter, the capping layer **390** is formed on the upper insulating layer **370** to cover the injection hole **307** and the injection hole forming region **307FP** to form the liquid crystal display having the configuration shown in FIGS. 2 and 3.

While embodiments have been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the embodiments are not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

DESCRIPTION OF SYMBOLS

300	sacrificial layer	305	microcavity
310	liquid crystal molecule	350	lower insulating layer
307	injection hole	370	upper insulating layer
360	roof layer		
390	capping layer		

What is claimed is:

1. A liquid crystal display comprising:
 - a substrate;
 - a thin film transistor disposed on the substrate;
 - a first protection layer disposed on the thin film transistor;
 - a pixel electrode disposed on the first protection layer;

11

a light blocking layer disposed on the pixel electrode to cover the thin film transistor;
 a second protection layer disposed on the light blocking layer; and
 a roof layer disposed to face the pixel electrode,
 wherein a plurality of microcavities having injection holes
 are formed between the pixel electrode and the roof
 layer, the microcavities comprise liquid crystal mol-
 ecules, and
 the first protection layer and the second protection layer
 have different etch rates.

2. The liquid crystal display of claim 1, wherein the first protection layer and the second protection layer comprise different materials.

3. The liquid crystal display of claim 2, wherein the second protection layer has high etch selectivity as compared with the first protection layer.

4. The liquid crystal display of claim 3, wherein the first protection layer includes a silicon oxide (SiOx) and the second protection layer includes a silicon nitride (SiNx).

5. The liquid crystal display of claim 4, further comprising an interlayer insulating layer disposed between the thin film transistor and the pixel electrode,
 wherein the pixel electrode and the thin film transistor are connected to each other through a contact hole formed penetrating through the interlayer insulating layer and the first protection layer.

6. The liquid crystal display of claim 5, wherein the second protection layer has a wider width than that of the light blocking layer to cover the light blocking layer.

7. The liquid crystal display of claim 6, further comprising a light blocking member disposed between the thin film transistor and the interlayer insulating layer,
 wherein the light blocking member has an open portion corresponding to the thin film transistor.

8. The liquid crystal display of claim 7, further comprising a color filter disposed between the thin film transistor and the interlayer insulating layer.

9. The liquid crystal display of claim 1, further comprising a capping layer disposed on the roof layer to cover the injection hole.

10. The liquid crystal display of claim 1, further comprising
 a common electrode disposed between the microcavities and the roof layer.

11. A manufacturing method of a liquid crystal display, the method comprising:
 forming a thin film transistor on a substrate;
 forming a first protection layer on the thin film transistor;
 forming a pixel electrode on the first protection layer;
 forming a light blocking layer on the pixel electrode in cover the thin film transistor;

12

forming a second protection layer on the light blocking layer;
 forming a sacrificial layer on the pixel electrode;
 forming a roof layer on the sacrificial layer;
 forming a plurality of microcavities having injection holes by removing the sacrificial layer; and
 injecting a liquid crystal material into the microcavities, wherein the first protection layer and the second protection layer have different etch rates.

12. The manufacturing method of claim 11, wherein the forming of the second protection layer includes:
 forming a protection material layer on the pixel electrode to cover the light blocking layer; and
 patterning the protection material layer to form the second protection layer.

13. The manufacturing method of claim 12, wherein the second protection layer has high etch selectivity as compared with the first protection layer.

14. The manufacturing method of claim 13, wherein the first protection layer includes a silicon oxide (SiOx) and the second protection layer includes a silicon nitride (SiNx).

15. The manufacturing method of claim 14, further comprising
 forming an interlayer insulating layer between the thin film transistor and the pixel electrode,
 wherein the pixel electrode and the thin film transistor are connected to each other through a contact hole formed penetrating through the interlayer insulating layer and the first protection layer.

16. The manufacturing method of claim 15, wherein the second protection layer has a wider width than that of the light blocking layer to cover the light blocking layer.

17. The manufacturing method of claim 16, further comprising
 forming a light blocking member between the thin film transistor and the interlayer insulating layer,
 wherein the light blocking member is formed to have an open portion corresponding to the thin film transistor.

18. The manufacturing method of claim 17, further comprising
 forming a color filter between the thin film transistor and the interlayer insulating layer.

19. The manufacturing method of claim 11, further comprising
 forming a capping layer on the roof layer to cover the injection holes.

20. The manufacturing method of claim 11, further comprising
 forming a common electrode between the microcavities and the roof layer.

* * * * *